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EFFECT OF CARBON MONOXIDE ON PREGNANCY

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Christine A Norman MSc
David M Halton PhD CIH
Canadian Centre for Occupational Health and Safety

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This publication was prepared as a source of information for health and safety committees and others with an interest in understanding the effect of carbon monoxide exposure on pregnancy.

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250 Main Street East
Hamilton Ontario
L8N 1H6
416-572-2981
FAX 416-572-2206

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1. INTRODUCTION

Over the last two decades, an increasing number of studies have examined how external factors can affect pregnancy. These increased research efforts have coincided with a growing public concern about reproductive hazards.

The CCOHS Inquiries Service receives many questions about the health effects of exposure to carbon monoxide. The most difficult kinds of questions to answer have been those requesting information on the effects of carbon monoxide on an unborn child. Carbon monoxide is particularly dangerous because large amounts may be generated in workplaces and homes. Yet it is colourless, odourless and non-irritating. This means it has no properties to warn people of its presence. Carbon monoxide reduces the amount of oxygen delivered to an unborn child. The developing fetus requires a good supply of oxygen. The mother's exposure to carbon monoxide could affect the pregnancy.

To answer questions about the effects of carbon monoxide on the unborn child, CCOHS staff conducted an extensive review and evaluation of the scientific literature. This publication gives an easily understandable overview of CCOHS' findings. It evaluates human and animal information to see if carbon monoxide presents a risk to pregnancy. A scientific and much more technical review is also available.[1]

2. WHAT ARE SOME WORKPLACE SOURCES OF CARBON MONOXIDE?

Carbon monoxide is a by-product in many industrial processes, particularly those involving incomplete burning of fuels such as gasoline, diesel fuel, kerosene and organic materials such as wood, coal or solvents. Forklifts operating in poorly ventilated warehouses may generate significant amounts of carbon monoxide. Foundry processes and power plant operations also produce carbon monoxide.

Cigarette smoke contributes to carbon monoxide in workplaces. Also ventilation and air-conditioning systems in some buildings take their "fresh" air from areas adjacent to parking lots or busy streets. In this way, carbon monoxide generated by auto engines outside a building can be brought inside and may accumulate.

Another occupational source of carbon monoxide is methylene chloride, which is used as a degreaser and paint stripper. When inhaled, methylene chloride is broken down in the body to carbon monoxide. Heavy exposure to methylene chloride can result in a build-up of carbon monoxide in the body.

3. IS CARBON MONOXIDE HARMFUL TO PEOPLE?

Yes, carbon monoxide is a toxic gas. It reduces the amount of oxygen reaching tissues. It does this by displacing oxygen from blood. Severe, acute exposures to carbon monoxide can be life-threatening. There are reports of fatal carbon monoxide exposures in the workplace.[2] Long-term exposure to carbon monoxide may also contribute to heart problems.[3]

Carbon monoxide exposure during pregnancy is particularly hazardous. In the first trimester, reduced oxygen to the fetus may impair organ development. In the second trimester, the mother has an increased need for oxygen and is particularly vulnerable to carbon monoxide exposure during this period. In the third trimester, the mother may suffer "breathlessness" due to the size of the growing fetus. Carbon monoxide exposure during this period aggravates this breathlessness and causes stress in both the mother and the unborn child.

4. CAN ACUTE EXPOSURES TO CARBON MONOXIDE AFFECT PREGNANCY?

Yes, high level acute exposures pose risks for both the mother and fetus. The child may not survive. When the child does survive, there may be evidence of nerve and muscle damage.

Scientific literature describes at least sixty reports of carbon monoxide exposures involving pregnant women.[1] Many of the early reports came from Europe where illuminating and coal gas were introduced into households in the mid 1800's for lighting and heating. More recent poisonings are largely related to furnace and stove leaks in residences. The fuels used in these heating devices were not specified but are likely to have been wood, manufactured gas or propane. Of all the carbon monoxide poisoning reports reviewed, only one involved a pregnant woman in a workplace (a restaurant). In many of the other cases, pregnant women were poisoned while at home.

What Are the Types of Effects?

Malformations occurred in some of the cases where the mother was poisoned in the first 3 months of pregnancy. These malformations included limb deformities and abnormalities in the mouth area. This type of damage was not seen with exposure at later stages of pregnancy. Evidence of brain or spinal cord damage was seen following severe exposure at any stage of pregnancy. Specific effects included poor muscle control and below-average mental development.

There were cases at all stages of pregnancy where exposures were severe enough to cause death to both the mother and the child. In other cases, the mother survived but the child was stillborn.

Only a few animal studies have evaluated the effect of sudden, severe carbon monoxide exposures on pregnancy. Like the human reports, these studies indicate the target organs for damage are the brain and spinal cord.[4-8]

Animal evidence clearly indicates that severe exposures to carbon monoxide during pregnancy can cause death or serious toxic effects to a fetus.

Can Effects on the Child be Predicted?

The review by CCOHS staff revealed that effects to the child were related to the amount of carbon monoxide in the mother's blood and the severity of symptoms seen in the mother.

Average carbon monoxide levels in the blood of pregnant women range from 0.4 to 2.6 percent for nonsmokers and from 2.0 to 8.3 percent for smokers.[9] In the case reports, noticeably high carbon monoxide levels were associated with poor fetal outcome. In all but one case, carbon monoxide levels of 48 percent or greater in the mother's blood resulted in the deaths of both the mother and child. There was a single exception, in which the mother's carbon monoxide level was 58.2 percent and both she and her child's outcome were good. However, this mother received rapid and intensive oxygen treatment which was probably responsible for the positive outcome.

Exposure to carbon monoxide can cause a range of symptoms in the mother. In forty-two case reports,[1] there was enough information on toxic effects to the mother to classify symptoms as mild, moderate or severe. Mild symptoms consisted of headache, dizziness, nausea, but with no period of unconsciousness. Moderate symptoms were those involving a period of unconsciousness or coma. Symptoms were defined as severe when the mother died. As the table shows, child outcome is poorer as the severity of symptoms in the mother increases.

Table - Toxicity in the mother versus child outcome
(Based on 42 Case Reports)

Outcome of the Child	Severity of Mother's Symptoms		
	# Mild Cases	# Moderate Cases	# Severe Cases
Good	4	2	---
Survival with Malformations and/or Functional Alterations	---	10	---
Death	---	15	11

In cases where the mother did not become unconscious, the outcome of the child was generally good. But in instances where the mother experienced unconsciousness or coma, the child either died or survived with severe abnormalities).

5. CAN REPEATED EXPOSURES TO CARBON MONOXIDE AFFECT PREGNANCY?

Many studies have indicated that women who smoke during pregnancy are more likely to have spontaneous abortions and to give birth to newborns with decreased birth weight.[10] Carbon monoxide is thought to be a contributing factor as this gas is a large component of cigarette smoke. Firm conclusions cannot be made as cigarette smoke also contains other toxic compounds such as nicotine and tar.

A number of animal studies have looked at pregnancy outcome by exposing pregnant animals to moderate concentrations of carbon monoxide for several days during pregnancy or throughout pregnancy. In some cases increased death of litters early in pregnancy was seen. Some offspring showed other effects, including lower birth weights, decreased growth, minor skeletal abnormalities, subtle behavioural effects and early death. These effects were seen at doses which did not cause obvious symptoms of poisoning in the mother.[11-14]

6. WHAT ARE THE FIRST AID MEASURES?

Almost any home and workplace can generate carbon monoxide. The gas has no warning colour or odour. The early symptoms of carbon monoxide poisoning, such as headache, dizziness, weakness and nausea, are not uncommon in the normal course of pregnancy.

If serious carbon monoxide poisoning is suspected, it is important for those involved in rescue to take precautions for their own safety. Precautions include:

- wearing appropriate protective equipment and using the "buddy system"
- moving the victim to fresh air as soon as possible
- shutting down or removing the source of carbon monoxide contamination, if this can be done safely
- having properly trained personnel begin artificial respiration or cardiopulmonary resuscitation (CPR) immediately if the victim's breathing has stopped
- having a trained person administer oxygen as soon as possible, preferably on a physician's advice, since this may be required to save the victim's life and that of the developing fetus.

7. SUMMARY

Too much carbon monoxide can kill anyone. In some circumstances, carbon monoxide can affect pregnancy outcome. Many case reports show that sudden, severe exposures to carbon monoxide, at any stage of pregnancy, can cause death or damage to the unborn child. However, in general, pregnancy outcome does not appear

to be affected unless exposure is severe enough to cause significant carbon monoxide increases in the mother's blood. Pregnancy outcome also does not seem affected unless the mother shows significant symptoms of poisoning such as unconsciousness or coma. In cases involving sudden exposures where the mother has low levels of carbon monoxide in the blood and no symptoms, the reports show no harm occurs.

The effect on pregnancy of repeated exposures to lower concentrations of carbon monoxide is less clear. Human information is inconclusive and animal studies have been carried out only at relatively high concentrations of carbon monoxide. Findings tend to support the general conclusion that effects on pregnancy can occur if the mother shows symptoms or has high blood levels of carbon monoxide.

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